for each service they propose at the time they file their applications, and to preempt state regulation to the maximum extent possible.

III. CONCLUSION

Viacom submits that the assignment of fixed frequency pairs to PCS licensees will result in higher relocation costs and lengthy delays in the provision of PCS service. Accordingly, Viacom recommends that the FCC adopt the Spectral Zone Coordination approach, under which two PCS licensees in a market are each assured a fixed allocation of 25 MHz in the 1850-1990 MHz band. Under this approach, in the event there is blockage within any PCS licensee's fixed allocation, each PCS licensee would have the flexibility to select needed frequencies within any unused portion of the 1850-1990 MHz band (such unused portion totalling 70 MHz if the FCC allocates 20 MHz to unlicensed services) for any given cell site pending completion of voluntary negotiations or ultimately arbitration and involuntary relocation, thereby minimizing the need for the relocation of incumbents and producing a variety of options for the few required relocations.

Alternatively, if the FCC decides, as it has proposed, to allocate three frequency blocks of 30 MHz each, Viacom recommends that the FCC apply the Spectral Zone Coordination technique to its proposed fixed block scheme, providing for a 30 MHz pool which can be accessed by PCS operators on a notification basis until incumbent users relocate as necessary. This type of

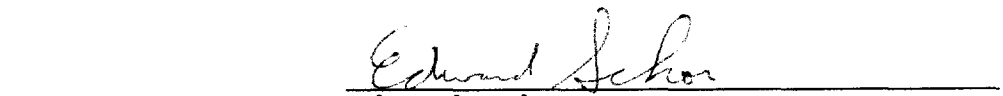
approach will retain most of the advantages of a fixed block scheme while adding much of the flexibility of the Spectral Zone Coordination methodology.

Viacom further recommends that the FCC assign only two PCS licenses per market, or in the alternative no more than three PCS licenses per market. As to the length of transition between voluntary and involuntary negotiations, Viacom submits that a longer transition period would be appropriate if the FCC authorizes use of additional pool frequencies under Spectral Zone Coordination, as Viacom has urged. Under the FCC's proposed fixed block scheme, however, the transition period should be no longer than three years. On the issue of unlicensed PCS, Viacom recommends that the FCC carefully consider the interference ramifications of unlicensed operations before setting aside any frequencies for unlicensed PCS.

Viacom also submits that cellular service areas are the appropriate service areas for PCS, since they are designed for wireless communications service and are the appropriate size for ensuring a profitable, diverse PCS operation. Viacom strongly opposes PCS licensing of cellular operators or local exchange carriers within their own service areas. In addition, Viacom recommends that the FCC impose a high filing fee per application and an "up-front" financial certification requirement (based on reasonable expectation of availability rather than a firm financial commitment) to discourage wide-scale speculation. Finally, given the uncertainties inherent in any new

communications service, PCS applicants should be allowed to select private or common carrier status at the time they file their applications.

Respectfully submitted,



Edward Schor
Senior Vice President
General Counsel/Communications
Viacom International Inc.
1515 Broadway
New York, New York 10036

(212) 258-6121

Date: November 9, 1992

Exhibit 1

Technical Showing in Support of the Comments of Viacom International Inc. on the Notice of Proposed Rulemaking for Personal Communications Services

The following submission is provided in support of the Comments of Viacom International Inc. on the Notice of Proposed Rulemaking in the Matter of Amendment of the Commission's Rules to Establish New Personal Communications Services.

Respectfully submitted,
Impulse Telecommunications Corporation

By: _____
Edward E. Jungerman
President

12720 Hillcrest Road, Suite 1020
Dallas, Texas 75230
(214) 490-8847

Dated: November 6, 1992

Technical Showing in Support of the Comments of Viacom International Inc.

1. Critique of Proposed Allocation

As a part of the Notice of Proposed Rulemaking in the matter of Amendment of the Commission's Rules to Establish New Personal Communications Services (hereinafter referred to as the PCS NPRM), the Commission has proposed a specific spectrum allocation in the 2 GHz band for licensed Personal Communications Services. This proposal and others in the PCS NPRM constitute a significant step towards PCS deployment.

As the PCS NPRM notes, "allocation decisions are among the most difficult that the Commission must make because virtually all the usable spectrum already is allocated to specific services, and most of it has been assigned to specific licensees."[1] This difficulty is compounded in the case of the 2 GHz allocation by the presence of an incumbency of fixed microwave operators in the band, who provide vital services to the nation and, as the Commission has stressed, deserve a fair and equitable spectrum sharing and relocation plan.

Viacom International Inc. (Viacom), and its consultant, Impulse Telecommunications Corporation (Impulse), have intensely studied spectrum sharing at 2 GHz. The resulting methods, breakthrough findings, and careful critiques of other methods have been documented in Viacom's Pioneer's Preference Request and related filings.[2]

Based on the expertise and insight into the spectrum sharing issues developed by Viacom and Impulse, this Technical Showing develops a constructive critique of the proposed allocation, specifically addressing the impact of the proposal as regards the critical spectrum sharing requirement.

Specifically, we find that the proposed allocation is lacking in flexibility and will seriously affect the viability of PCS as a new service that competes effectively with existing wireless communications providers. The reasoning for this position is developed in the following sections. Other, more flexible allocation and administration plans are outlined in Section 2.

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[1] PCS NPRM at ¶31.

[2] Request of Viacom International Inc. for a Pioneer's Preference in Personal Communications Network Services, May 4 1992, and subsequent Comments and Reply Comments.

1.1. Summary of proposed allocation

The Commission's primary allocation proposal for licensed PCS assigns 30 MHz to each of three operators in each service area. The size of the per-operator allocation is an attempt to balance the expectation of PCS competing with existing services (specifically cellular's 25 MHz per license) and the expectation that PCS operations, based on newer technology, may make more efficient use of the allocated spectrum.

We also note that the Commission recognizes the effects of the expected requirement for PCS to share spectrum with fixed microwave operators and suggests that more than 25 MHz be allocated to compensate the PCS operators for the sharing requirement:

> If sharing is required, the capacity of spectrum available to PCS services would be limited and spectrum blocks larger than 25 MHz may be needed at 2 GHz.[3]

The allocation proposed for each operator is split into frequency block pairs, with a separation of 80 MHz. This is consistent with the fixed microwave licenses and is held to provide "some advantages and flexibility" for PCS operators in sharing spectrum with incumbent operators.[4] If the Commission intends to require that PCS will necessarily use the paired blocks as "uplink and downlink" (to and from base station), Viacom objects since this is unnecessarily restrictive and would preclude other approaches and technologies that may result in higher spectrum efficiencies or facilitate spectrum sharing (for example, Time Division Duplex -- TDD).[5]

The Commission also asks for comments on other combinations of block sizes and larger numbers (four or five) of licensees.

Finally, the Commission notes that the proposals are contingent upon the outcome of the Emerging Technologies proceeding (Docket ET 92-9) which addresses negotiation with, and relocation of, fixed microwave operators.

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[3] PCS NPRM at ¶35, emphasis added.

[4] PCS NPRM at ¶39.

[5] The PCS NPRM explicitly recognizes the possibility of TDD at ¶38; on the other hand, Appendix A (Proposed Rules) appears to assume that the two parts of each block would be used separately for base station transmissions and mobile station transmissions (i.e., Frequency Division Duplex). See, for example, §99.405 (Frequencies) in Appendix A where, for example, 1850-1865 MHz is assumed to be licensed for base station transmission only and 1930-1945 MHz for mobile/portable station transmission.

1.2. The proposed allocation is inflexible and leads to high relocation costs

The PCS NPRM proposal of a fixed block results in a high likelihood of a PCS operator interfering with incumbents and, further, severely limits the options available to the PCS operator to resolve the interference. The nature of the problem is indicated by Figure 1-1.

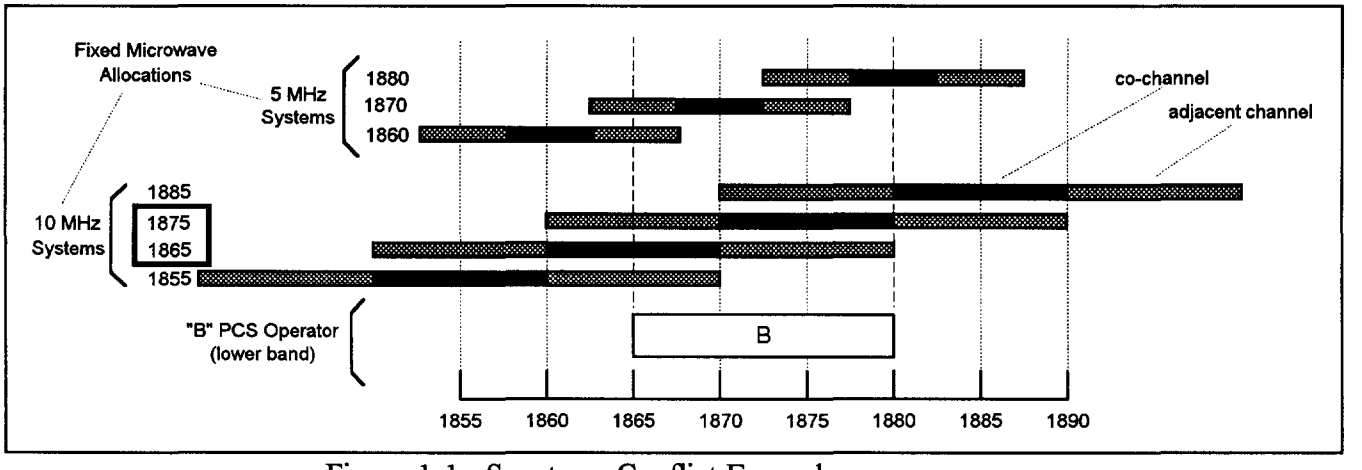

Figure 1-1: Spectrum Conflict Example

The example depicted in the figure shows the "B" PCS operator (lower) band, along with the fixed microwave channels and adjacent channels that overlap that band.[6] The figure shows that if a 10 MHz microwave path at either 1875 MHz or 1865 MHz (boxed in Figure 1-1) exists in B's service area along with the paired path, **there is a geographical area in B's service area where B's service is totally blocked**. The size or location of the area is, of course, not determined by this simple view.[7] In this situation, operator B has no option other than to negotiate to relocate the incumbent. More flexible spectrum management, such as the Spectral Zone Coordination technique proposed by Viacom, would provide other alternatives and limit the need for relocation of incumbents.

Under the proposed allocation, expensive and time-consuming negotiation or adjudication is the only recourse. Further, since the PCS operator has no alternatives, the incumbent can take an unreasonable position which could lead to years of delay under the relocation rules contemplated. This generates revenue losses and negotiation costs for operators, delay in the introduction of competitive personal communications services, and additional burdens on the Commission. At worst, interference may make a PCS operation in some

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[6] At ¶110, the Commission proposes the use of EIA/TIA's publication TSB10-E as the basis for calculating harmful interference to incumbent microwave operators from PCS. Specifically, at ¶111, it is proposed that the PCS licensee limit both co-channel and adjacent channel interference to the microwave receivers. Thus, the PCS operator must avoid harmful interference over a 30 MHz band (the licensed channel and the two adjacent channels).

[7] The size of the exclusion zone (the number of cells where B cannot operate) is determined by the details of the co-channel and adjacent channel interference rules, antenna height, power, etc.; at least one cell is affected.

areas simply too expensive and result in no competition in those areas. This outcome can occur in the most congested areas, which also happen to be the most lucrative markets.

Further, the example indicates that the split band approach may not be useful. The lack of flexibility involved in two relatively small bands may offset any gains achieved in clearing both transmit and receive microwave channels. In fact, some radio technologies that have been proposed require contiguous spectrum larger than 15 MHz.[8] Splitting the band as proposed precludes the use of these technologies.

In order to clarify the impact of the allocation proposed in the PCS NPRM nationally, Viacom has undertaken a new analysis of the microwave paths in each MSA nationwide (the Fixed-Band Impact Study).[9] The analysis method is illustrated by the previous figure and simply counts those situations where an existing microwave path will block the upper and/or lower blocks of the proposed A, B or C band. Again, this method does not characterize the size of the exclusion zone but only indicates the presence of one or more such zones in the MSA.

The results of the Fixed-Band Impact Study show:

- All three operators are blocked in at least one area in **155 MSAs.**[10]
- At least one operator is blocked in 247 MSAs.
- A total of **1520 paths** must be relocated to clear all MSAs for all three bands[11]
- Nationally, the cost to relocate these paths totals **$212 million**.[12]

The nationwide analysis based on the Spectral Zone Coordination methodology previously reported by Viacom shows markedly different results: only 14 MSAs had interference problems that would require negotiation and relocation of incumbents, at a cost of $25

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[8] PCN America has proposed "Wideband CDMA" which requires a single band wider than 15 MHz, according to the PCN America Pioneer's Preference request as amended April 30, 1992.

[9] The Fixed-Band Impact Study analyzed Comsearch's database of over 4,700 point-to-point microwave paths. Comsearch is the leading frequency engineering company in the U.S. Results of the Fixed-Band Impact Study are presented in the Appendix to this Showing.

[10] This result assumes the PCS technology can still use the upper band if the lower band is blocked. If the PCS always requires spectrum in both bands (e.g., a dedicated uplink band and a dedicated downlink band), then the 155 MSAs grows to 191 MSAs.

[11] The A band has 624 blocking microwave paths, the B band has 566, and the C band has 604. The total is 1794, but this total includes some double counting since, for example, a single 10 MHz microwave path at 1865 MHz blocks both the lower A band and the lower B band.

[12] A typical cost to relocate a microwave path to the 6 GHz band is $140,000.

million, only about **12% of the sharing cost of the allocation proposed in the PCS NPRM.** The Spectral Zone Coordination analysis assumed two operators at 25 MHz each, and used 140 MHz as a "pool" from which to draw spectrum to solve interference problems on a cell-by-cell basis.

There is no doubt that, no matter what assumptions concerning allocation are made, and what specific sharing technique is used, resolution of conflicts with incumbents will cost PCS operators money in some MSAs. Under the Spectral Zone Coordination method, the costs are nominal compared with the expected start-up costs. Further, the operators often have several recourses, and thus can reach resolution relatively quickly.[13] Viacom believes, in fact, that Spectral Zone Coordination results in the **lowest possible overall costs for relocation.**

In San Francisco, for example, spectrum sharing under Spectral Zone Coordination required the relocation of only two microwave paths to provide two operators with 25 MHz each. In contrast, under the less flexible rules proposed in the PCS NPRM, the A band is blocked 11 times, the B band 11 times, and the C band 9 times.[14] The reduced flexibility to use idle spectrum on a cell by cell basis causes a dramatic **ten-fold increase** in the number of microwave paths that block PCS coverage.

The proposed allocation offers so little flexibility and so few options that the burden of resolving spectrum conflicts may threaten the viability of a PCS operation, both in terms of cost and delay in entering a market window that will close as cellular begins to offer advanced digital services at reasonable prices.

1.3. The proposed allocation may be unfair to individual licensees

Under the proposed allocation, some licensees are very likely to experience more spectrum conflicts than others in the same service area and have no recourse but relocation of the incumbents. The Fixed-Band Impact Study described above shows that this inequitable situation exists in 233 of the 247 MSAs that have conflicts (94%). Further, in 92 of the MSAs, only one or two of the three operators has conflicts while the remaining operator(s) have none. The largest inequity, ten conflicts, occurs in Philadelphia, where the C band has 12 blocking microwave paths, and while the B band only has 2.

Thus, the proposed allocation leads to many inequitable situations where some licenses are more valuable (less cost to deploy) than others. This will clearly require a mechanism to

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[13] The Spectral Zone Coordination analysis showed that, in many cases, the effects of several microwave paths caused "red cells" (cells that cannot operate due to spectrum shortage) and that removal of one or two paths would resolve the problem (free enough spectrum from the pool for operation). Thus, the PCS operator could negotiate with each of several parties, and not be "held up" by a single microwave operator.

[14] Using the even less flexible uplink/downlink constraint, the numbers are 30 blocking paths for the A band, 24 for the B band, and 21 for the C band.

level the playing field for the PCS operators. The result of the allocation is more costs and delays and a considerable administrative and regulatory burden on the Commission.

Since the Spectral Zone Coordination technique results in far fewer conflicts, the overall impact of inequities is markedly reduced, compared to the proposed allocation.

1.4. The proposed allocation does not ensure spectrum equivalence to cellular

One of the stronger forces behind the Commission's PCS initiative is to ensure competition in the personal communications industry. Clearly, new PCS operators will compete with cellular and cellular will offer PCS-like services. Thus, a major issue is the provision of balanced competition between new and existing services; the foundation of wireless operation and the basis for competition is spectrum.

As noted above, the Commission has recognized that PCS operators will bear a burden because of the sharing requirement, and has accordingly allocated more spectrum to PCS. However, the proposed allocation does not provide for balanced competition between cellular and PCS.

Clearly, in areas where there is no congestion, PCS (with 30 MHz per operator) has a spectrum advantage over cellular (with 24 MHz per operator). Even in areas where there is some congestion, PCS has an overall spectrum advantage over most of the area.

However, in high population areas (which are, at the same time, excellent markets and spectrally highly congested), there is no mechanism to ensure that PCS operators do not have a spectrum disadvantage. As indicated by the analysis above, the additional 5 MHz allocated to each PCS operator does little to improve the situation and there are a large number of situations where, if not totally blocked, the PCS operator may be limited spectrally relative to cellular. Of course, the PCS operator has recourse to relocation, but this only adds delay (while cellular offers services) and cost (which is not borne by cellular).

In contrast, Spectral Zone Coordination results in spectrum allocation **exactly equivalent to cellular** after resolution of spectrum sharing conflicts, and only modest relocation costs that should not impede PCS's ability to compete with cellular.

1.5. The proposed allocation for unlicensed PCS in a shared band is questionable

The PCS NPRM proposes that the unlicensed PCS band be 1910-1930 MHz, co-primary with part 94 private fixed microwave operators, and seeks comment on this proposal.

Although the Spectral Zone Coordination method is not adversely affected by this proposal (except, of course, that the pool of spectrum available is slightly reduced), Viacom observes that difficulties may arise from allocation for unlicensed operation in a shared band:

a. If a microwave operator experiences interference, it is difficult to imagine how the source of the interference could be identified, located and dealt with.[15] We note that, although the power for individual devices can be limited, there is no limit on the total number of devices that may be transmitting at any instant. Interference is the combined impact of the total emission from all users in specific geographical areas in a band.

b. Since some microwave licenses overlap both the licensed and unlicensed PCS band, a microwave operator with such a license would be exposed to interference from both a licensed PCS operator and the unlicensed PCS band. Since this interference would sum, and since the licensed operator is identifiable, the licensed PCS operator may be subject to disputes with incumbents, when, in fact, the cause of the interference is unknowable usage patterns of unlicensed devices.

2. Application of Spectral Zone Coordination to the Proposed Allocation

The original Spectral Zone Coordination application assured two 25 MHz maximum allocations for each of two operators by treating the 1850-1990 MHz band as a spectrum pool. **This application of Spectral Zone Coordination is the least cost, and most rapidly deployable, sharing method for PCS operators.**

As we have indicated, the original Spectral Zone Coordination analysis was based on certain decisions that determined input parameters to the analysis and computer model. These decisions were based on certain assumptions concerning the overall PCS industry and resulted in the lowest overall costs. Since Spectral Zone Coordination is parameter-driven, the Spectral Zone Coordination method can be applied to the other proposals with other combinations of licensees and spectrum allocation. **If, in its consideration of all the issues, the Commission prefers a more rigid allocation based on fixed spectrum blocks, Spectral Zone Coordination can be applied to reduce the spectrum sharing costs and delays associated with such allocation schemes.** The following sections describe such applications.

2.1. Two PCS Licensees per Service Area at 25 MHz Each

This section describes the application of the original Spectral Zone Coordination proposal (allocation of 25 MHz for two operators, per service area) with a more detailed discussion of administration:[16]

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[15] Note that the control channels inherent in PCS devices provide a technical mechanism for identifying and resolving interference problems.

[16] This section takes into account the allocation for unlicensed PCS which was not accounted for in the parameters used for the original Spectral Zone Coordination study.

a. Identify two preferred, fixed contiguous 25 MHz blocks (A and B) and form a pool of the remaining spectrum (70 MHz) in each area (see Figure 2-1).[17]

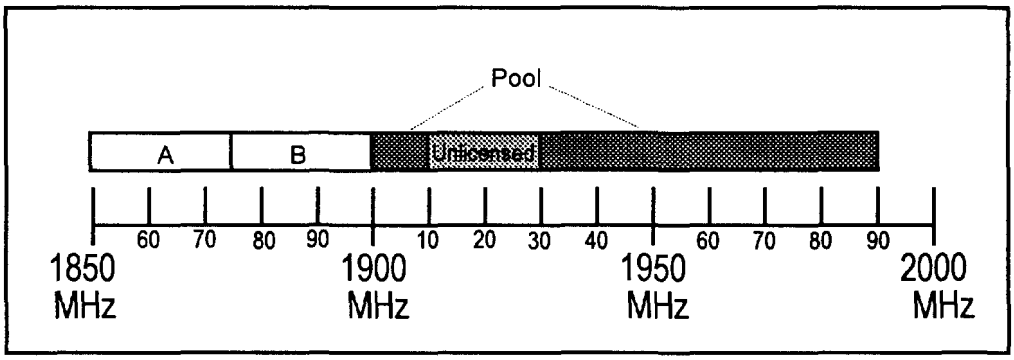

Figure 2-1

b. In the event that a PCS operator finds it cannot use its preferred fixed band in a cell due to the presence of an incumbent fixed microwave operator that refuses to relocate, the PCS operator would be responsible for identifying frequencies from the pool to solve the sharing problem through frequency coordination. The PCS operator would then file a notification with the Commission stating that he intends to operate on the selected pool frequencies at that cell site.[18] The notification would include complete documentation of frequency coordination, establishing that the frequency is available for use without interference to existing licenses.[19] The notification could also be required to provide evidence that the PCS operator has initiated negotiations with the incumbent microwave operator.

c. The notification would be placed on Public Notice by the Commission. If no objections are filed within 30 days of the publication, the notification would become a conditional authorization for the PCS operator to use the requested pool frequencies until the date on which the incumbent actually relocates, pursuant either to voluntary relocation or involuntary relocation, conducted according to the procedures adopted in Docket 92-9 and within the time limits adopted by the Commission for relocations.

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[17] The location of the fixed blocks may be selected in each service area to minimize sharing problems; the figure shows arbitrary locations.

[18] The procedure is analogous to the addition of cell sites pursuant to Sections 22.23(c)(3) and 22.9(d) by authorized cellular radio stations within their Cellular Geographic Service Areas, except that, as noted above, a 30-day objection period is provided to ensure against interference.

[19] Since the notification is not an application, but merely implements authorized use of a reserve frequency pool, Viacom recommends that the Commission not charge a filing fee for such notifications.

d. Upon relocation of the incumbent, the PCS operator would be responsible for canceling the conditional authorization and operating within the preferred band as promptly as possible.

The process of attrition (no new primary licenses for fixed microwave), new technology, and other influences and tools defined by Commission (e.g., involuntary relocation per ET 92-9) will eventually "re-regularize" the 1850-1990 MHz band and provide reserve spectrum for additional or new services. Note that due to the expected frequency agile nature of PCS, these adjustments would be transparent to and impose no burden whatsoever on the PCS subscribers.

2.2. Three PCS Licensees per Service Area at 30 MHz Each

If the Commission decides to allocate more spectrum per operator and/or more operators, the sharing principles described here are still valid. Assuming that all available spectrum is not assigned, allowing the licensees flexibility in spectrum usage to avoid blockages serves to minimize the cost of sharing and facilitates the operation of free market mechanisms in the process of relocating incumbents.

For three licensees granted 30 MHz each, the spectrum pool is 30 MHz as indicated in Figure 2-2. Clearly, since the size of the pool is reduced, the effectiveness of the Spectral Zone Coordination technique in granting temporary use of spectrum from the pool is also reduced. However, the cost of relocation is less than the fixed block allocation proposed by the PCS NPRM.

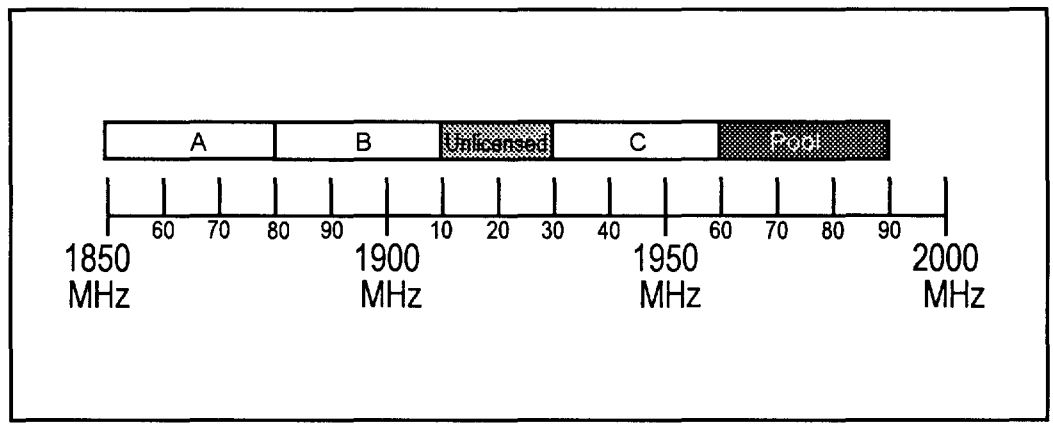

Figure 2-2

3. Conclusions

- The fixed block allocation proposed in the PCS NPRM is inflexible with respect to spectrum sharing and will result in high costs to the new PCS operators, long delays and a large administrative and regulatory burden. These factors may threaten the viability of the new services.

- The Spectral Zone Coordination method is the least-cost method for sharing in the 1850-1990 MHz band.

- The administration of Spectral Zone Coordination, as described herein, imposes only a small burden on the Commission.

- Over time, the process described herein causes a migration to a fixed allocation which is fair relative to cellular and provides a reserve for other emerging applications.

- Application of Spectral Zone Coordination to fixed block allocations results in earlier introduction of service and lower sharing costs than the inflexible allocation proposed in the PCS NPRM.

Appendix: National PCS NPRM Fixed-Band Impact Study

Overview

Any system that assigns spectrum to PCS with a sharing constraint, to protect the current fixed microwave paths, has some cost impact due to that constraint. When planning contiguous wide area coverage, the PCS licensee will often find some number of blocking microwave paths. The primary option to unblock these areas is to negotiate with the owner of the microwave path to relocate the frequency channel for that path to another microwave band (in this case, often to the 6 GHz band).

The expectation is that the PCS licensee will pay the costs for that relocation. The total cost depends on the number of paths relocated, and one of the primary determining factors is the degree of spectrum flexibility granted to the PCS licensee. Viacom's national Spectral Zone Coordination study was based on two PCS licenses with *total flexibility* within the 1850-1990 MHz band to work around the microwave paths.[20] The current PCS NPRM proposal is based on three PCS licenses that allocate *fixed PCS bands with no flexibility*.

Under Spectral Zone Coordination rules, PCS generally could work around a blocking microwave path by using some unassigned spectrum outside of the fixed band defined by the PCS license, and only rarely (as the last resort) was relocation to the 6 GHz band required. Under the proposed PCS rules, the only option is to relocate the microwave path. Intuitively this will require more path relocations, and so this is a more expensive alternative. This Fixed-Band Impact Study was undertaken to determine how many microwave paths require frequency relocation under the PCS NPRM rules.[21]

Methodology

The table included in this Appendix lists the number of microwave paths which impact the capability of each PCS licensee to provide full area coverage. A PCS licensee is prevented from having full wide area coverage if **both** the lower 15 MHz of the PCS block **and** the upper 15 MHz are covered. Each 10 MHz microwave path impacts 30 MHz of shared spectrum when considering both co-channel and the two adjacent channels. Each lower

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[20] Spectral Zone Coordination assigns fixed bands to each PCS operator, but allows substitution of other spectrum on a cell-by-cell basis to provide the flexibility to work around blocking microwave paths.

[21] Impulse used the services of Comsearch, the leading spectrum engineering company in the U.S., to determine the number of microwave paths in each MSA which met the blocking criteria, using the same national microwave path database that was used for the Spectral Zone Coordination study.

15 MHz band is fully covered by the 30 MHz impact from either of two microwave bands.[22] This is also true for each upper 15 MHz band.

Thus, Block A is prevented from having wide area coverage when both of the following are true for the two licensed frequencies of any single two-way microwave path:

Lower band is impacted when in the path of 1855 MHz **or** 1865 MHz.
Upper band is impacted when in the path of 1935 MHz **or** 1945 MHz.

Similarly, for Block B:

Lower band is impacted when in the path of 1865 MHz or 1875 MHz.
Upper band is impacted when in the path of 1945 MHz or 1955 MHz.

Similarly, for Block C:

Lower band is impacted when in the path of 1885 MHz or 1895 MHz.
Upper band is impacted when in the path of 1965 MHz or 1975 MHz.

Note that only 10 MHz microwave licenses are included in this study. For 5 MHz microwave licenses, the total shared spectrum impacted is 15 MHz (again counting both the co-channel and the two adjacent channels), which could only totally prevent wide area PCS coverage if exactly aligned with a PCS licensee. The rules as proposed never support such perfect alignment, so there is no way for a 5 MHz path acting alone to totally prevent wide area PCS coverage. In the worst case, the PCS licensee would still have 2.5 MHz of non-shared spectrum.

Also note that 10 of the 14 microwave bands block a full lower or upper band of at least one PCS license.

In reality, combinations of paths may produce overlapping exclusion zones that prevent PCS coverage. This study did not evaluate the impact of this scenario, so the results presented below are conservative. To the extent that overlapping occurs, the actual impact is greater than the impact shown below.

Also note that some microwave paths impact both Block A and Block B PCS licenses. The data presented below lists the actual impacts for each Block, which includes the double counting for those paths which impact both A and B. The "Total" number of relocations in the tables, however, adjusts for any double counting. Thus the "Total" is the actual number of microwave paths which impact at least one PCS license block, and this total is often slightly less than the sum of the A plus B plus C columns. The total is always less than or equal to the number of paths.

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[22] This analysis assumes that both the co-channel and the adjacent channel harmful interference criteria result in non-zero exclusion zones, and that the exclusion zones from both ends of the microwave path have some area of overlap. Impulse's Spectral Zone Coordination study results support the reasonableness of this assumption.

Results

The first part of the Fixed-Block Impact Study assumes that the PCS fixed blocks as defined in the PCS NPRM allow the PCS licensee to use either the upper 15 MHz band or the lower 15 MHz band as necessary to work around blocking microwave paths (assuming that the PCS radio link technology permits this). Under this assumption, *PCS is blocked only if* ***both*** *the upper band and the lower band are totally blocked.* In this case the study shows:

PCS License	Relocations
A	624
B	566
C	604
Total	1520

As stated above, there is some double counting since some of the microwave paths block more than one PCS license, so the total path relocations are 274 less than the sum of A plus B plus C.

This study shows that at least 1520 relocations are required to allow wide area PCS coverage in all MSAs. The actual number would be larger if the study also included the impact of multiple overlapping microwave paths. Under Spectral Zone Coordination, with total PCS spectrum flexibility, the number of path relocations is estimated at less than 171.[23] The less flexible PCS rules proposed in the PCS NPRM results in an approximate ten-fold increase in the number of relocations and the associated cost of sharing.

This comparison between Spectral Zone Coordination and the proposed PCS rules is biased in that the PCS rules provide for three PCS licenses, while Spectral Zone Coordination assumed two PCS licenses. If the PCS rules are adapted to allow just two 30 MHz PCS licenses, but still without the flexibility allowed by Spectral Zone Coordination to use frequencies from a pool to resolve blockages, then the blocking impact depends on which two blocks are allocated, as shown in the tables below.

PCS License	Relocations	PCS License	Relocations	PCS License	Relocations
A	624	A	624		
B	566			B	566
		C	604	C	604
Total	916	Total	1228	Total	1170

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[23] *Spectral Zone Coordination: Fast Track to PCN, Engineering Reference and Study Findings,* Impulse Telecommunications Corporation, 1992, p 8.15.

Again, the "Totals" account for double counting, as described above.

This example shows that the number of relocations forced by the Commission's spectrum sharing constraint is still much higher than with Spectral Zone Coordination and varies considerably with the exact location of the dedicated PCS blocks.

As an interesting test of the impact of even more inflexible PCS rules, consider a further constraint requiring cell transmitters to use only the lower band and mobile phone transmitters to use only the upper band. Then the reduced flexibility increases the number of blocking paths. *PCS is blocked if **either** the upper band **or** the lower band is blocked.* Under this scenario there are two types of paths to consider. Almost all microwave paths are licensed for two-way communications, with a different 10 MHz microwave band each way, normally with an 80 MHz separation. Most blocking paths require two relocations, to move both the forward channel and the return channel to the 6 GHz band. Some (those that violate the normal 80 MHz channel spacing guideline) only require one relocation.

This is in contrast to the results presented in the previous case, where relocation of either the forward or reverse channel could provide enough spectrum for PCS operation. If a PCS radio link technology (e.g., Frequency Division Duplex) requires spectrum in both blocks, then PCS cannot operate if either band is fully blocked. The number of relocations required in this less flexible case is more than twice that shown above. Each of the blockages shown above now requires two relocations, plus there are some additional relocations for those paths that only blocked one of the two PCS bands.

The results of this case are:

PCS License	Relocations
A	1687
B	1576
C	1652
Total	4130

Again, there is double counting since some of the microwave paths block more than one PCS license, so the total path relocations are 785 less than the sum of A plus B plus C.

Nationally, there are 4,789 microwave paths in the 1850-1990 MHz band, of which 2,979 are within the 306 MSAs, or close enough to have an impact within an MSA. As nearly all are two-way, there are 5,958 microwave radios that potentially might be relocated. The inflexible uplink/downlink scenario requires relocation of 4,130 of these, which is just over 69%.

This example is included as part of this study to further illustrate the impact of spectrum flexibility (or lack of flexibility) on the cost of sharing. Spectral Zone

Coordination, the most flexible scenario, required the relocation of less than 171 radio links (3% of the total number). The dedicated uplink/downlink scenario with three PCS licenses, in contrast, require the relocation of 4,130 radio links (69% of the total).

This discussion has shown that the impact of the spectrum sharing constraint on PCS varies with both the location of the dedicated spectrum and with the degree of flexibility allowed. However, in all cases the impact of spectrum sharing under the proposed PCS rules is far greater than under the more flexible Spectral Zone Coordination rules.

The following table shows the results of the Fixed-Block Impact Study for all MSAs. These results are based on the first interpretation of the PCS rules (no requirement to operate with an up-band and a down-band) which implies that PCS is blocked only if **both**

Table of Microwave Path Relocations under PCS NPRM Proposed Rules

	MSA	Total Paths	Relocations Block A	Block B	Block C	Total
1	New York	26	11	7	8	24
2	Los Angeles	157	25	20	26	61
3	Chicago	34	4	3	4	11
4	Philadelphia	40	4	2	12	17
5	Detroit	32	8	5	3	13
6	Boston	31	7	6	6	15
7	San Francisco	54	11	11	9	28
8	Washington, DC	26	7	8	4	16
9	Dallas	61	11	9	15	30
10	Houston	71	8	8	8	21
11	St. Louis	26	4	3	6	11
12	Miami	34	5	6	10	17
13	Pittsburgh	10	0	3	1	4
14	Baltimore	38	8	13	12	27
15	Minneapolis	26	8	8	9	22
16	Cleveland	28	5	4	8	14
17	Atlanta	48	16	13	13	34
18	San Diego	24	5	2	3	10
19	Denver	15	3	4	4	8
20	Seattle	15	0	1	2	3
21	Milwaukee	17	2	2	3	5
22	Tampa	36	11	10	11	27
23	Cincinnati	28	7	8	6	18
24	Kansas City	26	7	9	6	19
25	Buffalo	14	5	3	3	10
26	Phoenix	25	1	3	6	9
27	San Jose	12	3	2	3	7
28	Indianapolis	10	2	1	2	5
29	New Orleans	27	3	1	8	11
30	Portland	17	3	3	6	11
31	Columbus	3	0	0	0	0
32	Hartford	5	0	0	1	1
33	San Antonio	23	4	2	6	11
34	Rochester	7	0	1	4	5
35	Sacramento	34	7	7	6	15
36	Memphis	27	2	3	3	8
37	Louisville	18	3	4	2	8
38	Providence	31	3	5	5	11
39	Salt Lake City	31	7	5	3	14
40	Dayton	8	3	3	1	5
41	Birmingham	26	5	6	5	14
42	Stamford	3	0	0	1	1
43	Norfolk	4	1	2	1	4
44	Albany	11	1	1	3	4
45	Oklahoma City	6	3	2	1	5
46	Nashville	5	1	2	2	4
47	Greensboro	20	7	6	4	13
48	Toledo	12	3	3	4	8

Table of Microwave Path Relocations under PCS NPRM Proposed Rules

	MSA	Total Paths	Relocations Block A	Block B	Block C	Total
49	New Haven	6	1	1	2	3
50	Honolulu	0	0	0	0	0
51	Jacksonville	24	6	6	10	19
52	Akron	15	4	3	7	13
53	Syracuse	9	2	2	1	4
54	Gary - Hammond	11	2	3	1	4
55	Worcester	10	3	3	2	6
56	Northeast	3	0	0	0	0
57	Tulsa	20	6	6	2	11
58	Allentown	3	0	0	0	0
59	Richmond	12	0	1	2	3
60	Orlando	35	10	10	7	22
61	Charlotte	12	4	3	1	7
62	New Brunswick	16	3	2	1	5
63	Springfield	7	2	2	1	4
64	Grand Rapids	5	0	0	0	0
65	Omaha	17	5	3	5	11
66	Youngstown	8	3	1	0	3
67	Greenville	4	2	0	0	2
68	Flint	4	1	0	1	2
69	Wilmington	4	0	0	3	3
70	Long Branch	6	1	2	1	3
71	Raleigh-Durham	12	4	1	6	11
72	West Palm Beach	15	2	2	5	8
73	Oxnard	24	3	1	1	5
74	Fresno	14	3	1	2	6
75	Austin	22	5	2	3	8
76	New Bedford	8	1	0	1	2
77	Tuscon	24	3	5	5	10
78	Lansing	9	1	3	2	5
79	Knoxville	3	1	1	1	3
80	Baton Rouge	27	6	4	5	13
81	El Paso	20	8	3	3	13
82	Tacoma	7	2	2	0	2
83	Mobile	18	3	2	2	6
84	Harrisburg	11	4	2	3	7
85	Johnson City	1	0	0	0	0
86	Albuquerque	12	4	3	2	7
87	Canton	7	2	2	3	6
88	Chattanooga	2	0	0	0	0
89	Wichita	6	0	1	3	4
90	Charleston	24	7	8	8	19
91	San Juan, PR	0	0	0	0	0
92	Little Rock-North Little	15	2	2	3	6
93	Las Vegas	28	3	4	2	7
94	Saginaw-Bay City-Midland	1	0	1	0	1
95	Columbia	7	2	1	1	4
96	Fort Wayne	7	1	1	3	4

Table of Microwave Path Relocations under PCS NPRM Proposed Rules

	MSA	Total Paths	Relocations Block A	Block B	Block C	Total
97	Bakersfield	31	8	6	3	13
98	Davenport-Rock Island-Mol	16	3	4	5	11
99	York	6	3	2	1	4
100	Shreveport	7	4	3	2	7
101	Beaumont-Port Arthur	28	5	4	4	11
102	Des Moines	1	0	0	0	0
103	Peoria	2	1	1	0	2
104	Newport News-Hampton	1	0	1	0	1
105	Lancaster	3	1	0	0	1
106	Jackson	17	3	1	5	8
107	Stockton	6	0	0	0	0
108	Augusta	6	2	3	1	5
109	Spokane	10	2	1	0	2
110	Huntington-Ashland	10	1	0	3	4
111	Vallejo-Fairfield-Napa	12	3	3	1	6
112	Corpus Christi	18	2	2	5	9
113	Madison	2	1	0	1	2
114	Lakeland-Winter Haven	2	1	1	0	2
115	Utica-Rome	4	1	1	1	2
116	Lexington-Fayette	7	2	1	1	3
117	Colorado Springs	8	3	1	1	4
118	Reading	3	0	0	0	0
119	Evansville	8	4	2	1	6
120	Huntsville	0	0	0	0	0
121	Trenton	4	1	1	1	2
122	Binghamton	5	4	3	0	5
123	Santa Rosa-Petaluma	7	0	1	2	3
124	Santa Barbara-Santa Maria	20	2	2	1	4
125	Appleton-Oskosh-Neenah	0	0	0	0	0
126	Salinas-Seaside-Monterey	4	1	0	1	2
127	Pensacola	34	8	10	9	22
128	McAllen-Edinburgh-Mission	8	2	4	1	5
129	South Bend-Mishawaka	5	0	0	2	2
130	Erie	1	0	1	0	1
131	Rockford	2	0	0	0	0
132	Kalamazoo	2	0	1	0	1
133	Manchester-Nashua	5	0	0	0	0
134	Atlantic City	12	3	5	5	12
135	Eugene-Springfield	13	4	4	3	9
136	Lorain-Elyria	5	1	1	0	1
137	Melbourne-Titusville-Palm	5	0	0	1	1
138	Macon-Warner Robins	11	3	1	2	5
139	Montgomery	17	4	4	1	7
140	Charleston	3	3	1	0	3
141	Duluth	19	7	4	3	11
142	Modesto	4	1	1	0	2
143	Johnston	2	0	0	0	0
144	Orange County	8	2	3	3	8

Table of Microwave Path Relocations under PCS NPRM Proposed Rules

MSA		Total Paths	Relocations Block A	Block B	Block C	Total
145	Hamilton-Middletown	12	4	4	1	7
146	Daytona Beach	12	3	3	4	9
147	Ponce, PR	0	0	0	0	0
148	Salem	5	0	1	2	3
149	Fayetteville	0	0	0	0	0
150	Visalia-Tulare-Portervill	7	2	2	0	3
151	Poughkeepsie	0	0	0	0	0
152	Portland (NECMA)	7	2	2	3	6
153	Columbus	3	1	1	1	3
154	New London-Norwich	2	0	0	0	0
155	Savannah	8	1	0	1	2
156	Portsmouth-Dover-Roch.	4	1	0	2	3
157	Roanoke	2	1	1	0	1
158	Lima	0	0	0	0	0
159	Provo-Orem	11	1	0	0	1
160	Killeen-Temple	4	2	0	1	3
161	Lubbock	4	1	1	1	3
162	Brownsville-Harlingen	4	2	2	1	4
163	Springfield	5	1	0	1	2
164	Fort Myers	6	2	0	2	4
165	Fort Smith	4	1	1	1	2
166	Hickory	2	1	1	1	2
167	Sarasota	5	1	1	2	3
168	Tallahassee	7	2	1	1	3
169	Mayaguez, PR	0	0	0	0	0
170	Galveston-Texas City	11	0	0	0	0
171	Reno	5	1	0	1	2
172	Lincoln	8	1	3	2	6
173	Biloxi-Gulfport	0	0	0	0	0
174	Lafayette	23	3	4	3	8
175	Santa Cruz	3	2	1	1	3
176	Springfield	5	1	3	2	5
177	Battle Creek	1	0	0	1	1
178	Wheeling	0	0	0	0	0
179	Topeka	2	0	0	0	0
180	Springfield	0	0	0	0	0
181	Muskegon	0	0	0	0	0
182	Fayetteville-Springdale	2	1	1	0	1
183	Asheville	2	0	1	0	1
184	Houma-Thibodaux	30	5	5	5	12
185	Terre Haute	5	3	3	1	5
186	Green Bay	2	0	0	0	0
187	Anchorage	0	0	0	0	0
188	Amarillo	8	1	1	0	1
189	Racine	0	0	0	0	0
190	Boise City	10	1	1	6	8
191	Yakima	6	2	2	2	5
192	Gainesville	12	3	5	4	10

Table of Microwave Path Relocations under PCS NPRM Proposed Rules

MSA		Total Paths	Relocations Block A	Block B	Block C	Total
193	Benton Harbor	3	0	0	0	0
194	Waco	3	1	0	1	2
195	Cedar Rapids	2	1	1	1	2
196	Champaign-Urbana-Rantoul	3	2	1	0	2
197	Lake Charles	12	1	1	0	1
198	St. Cloud	10	4	5	1	8
199	Steubenville-Weirton	1	0	1	0	1
200	Parkersburg-Marietta	1	1	0	0	1
201	Waterloo-Cedar Falls	0	0	0	0	0
202	Arecibo, PR	0	0	0	0	0
203	Lynchburg	9	3	2	3	6
204	Aquadilla, PR	0	0	0	0	0
205	Alexandria	11	2	2	2	5
206	Longview-Marshall	15	4	4	3	10
207	Jackson	2	0	1	0	1
208	Fort Pierce	3	0	1	1	2
209	Clarksville-Hopkinsville	0	0	0	0	0
210	Fort Collins-Loveland	6	1	1	2	3
211	Bradenton	6	1	1	1	2
212	Bremerton	6	1	1	3	4
213	Pittsfield (NECMA)	5	1	1	1	2
214	Richland-Kennewick-Pasco	11	2	3	3	7
215	Chico	8	1	2	1	3
216	Janesville-Beloit	0	0	0	0	0
217	Anderson	2	0	0	0	0
218	Wilmington	6	2	1	2	4
219	Monroe	9	1	1	2	3
220	Abilene	12	0	1	1	2
221	Fargo-Moorehead	1	0	1	0	1
222	Tuscaloosa	7	1	3	2	5
223	Elkhart-Goshen	0	0	0	0	0
224	Bangor (NECMA)	4	0	0	1	1
225	Altoona	2	0	0	0	0
226	Florence	0	0	0	0	0
227	Anderson	3	1	0	0	1
228	Vineland-Millville-Bridge	2	0	0	2	2
229	Medford	9	5	2	2	8
230	Decatur	0	0	0	0	0
231	Mansfield	0	0	0	0	0
232	Eau Claire	6	4	3	1	5
233	Wichita Falls	2	0	0	1	1
234	Athens	3	1	0	0	1
235	Petersburg-Colonial Heigh	3	0	1	0	1
236	Muncie	0	0	0	0	0
237	Tyler	6	2	3	2	6
238	Sharon	2	1	1	1	2
239	Joplin	5	2	2	1	4
240	Texarkana	7	2	2	0	3